dependent claim 9, the amendment to independent claim 7 does not raise new issues requiring further search and/or consideration.

At page 2 of the Office Action the Examiner indicates that the restriction/election of species requirement is final. Applicants acknowledge the restriction/election of species requirement, and reserve the right to file one or more divisional applications directed to the non-elected subject matter.

Also at page 2 of the Office Action, the Examiner objects to phrases at page 1, line 19, and at page 12, line 25 of the specification. In response, Applicants have amended the specification.

At page 3 of the Office Action, the Examiner objects to the drawings, and requests that Figures 1 and 2 be labeled as prior art. In response, a Request For Approval of Drawing Correction is being submitted herewith, with the proposed changes requested by the Examiner.

**Obviousness based on Ogino et al., Yamagata et al., and Miller et al.**

At page 3 of the Office Action, claims 6-9 and 11-13 are rejected as obvious in view of Ogino et al. (U.S. Patent No. 6,471,821), Yamagata et al. (U.S. Patent No. 5,362,358), and Miller et al. It is believed that the Examiner intended to refer to claims "7"-9 and 11-13, since claim 7 is independent. If this was not the Examiner's intention, clarification is requested.

As noted above, independent claim 7 is amended to incorporate the limitation in dependent claim 9 so that independent claim 7 is the same as canceled dependent claim 9. With respect to dependent claim 9 (which is now in the form of independent claim 7), the Examiner states the following:

> Regarding claims 8 and 9, the apparatus of Yamagata et al. (Fig. 8) further includes an amplifier 90 for amplifying the modulated signal, and an impedance matching network 52. Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to implement the amplifier and the impedance matching network as taught by

> Yamagata et al in the apparatus of Ogino et al in order to amplify the modulated signal and to more efficiently apply [the] signal to the chamber.

The Examiner also relies on the FIGS. 1 and 2 of Ogino et al. in the rejection. FIG. 2 of Ogino et al. shows a waveform with a first subcycle 25 and a second subcycle 26. The first and second subcycles 25, 26 are at substantially different frequencies. This rejection is traversed.

1. *Obviousness has not been established, because adding a single matching network to Ogino et al's plasma reactor would result in less efficient power delivery, and not more efficient power delivery as alleged by the Examiner.*

The obviousness rejection is improper, because there is no motivation to modify the prior art in the manner suggested by the Examiner. Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so. *In re Fine*, 5 USPQ2d 1596 (Fed. Cir. 1988). One skilled in the art would not have been led to modify Ogino et al.'s plasma reactor with a matching network, since doing so would result in <u>less</u> power being transferred to a processing chamber, and not "more" efficient power transfer as alleged by the Examiner.

As explained at page 7, lines 5-7 of the specification, a matching network minimizes power reflections from a power source (p. 7, l. 5-7 of the specification). If too much power is reflected back to the power source, the power source may be detrimentally driven into foldback (p. 2, l. 20-24 of the specification). As explained at page 2, lines 13-24 of the specification, *a matching network is generally adapted to allow a power signal at a single frequency to efficiently pass to the processing chamber*. For example, a power source providing power at 100 MHz uses a matching network designed to reduce reflections of power at 100 MHz (see page 2, lines 20-21, and page 12, line 33 to page 13, line 1 of the specification). As a further illustration of this point, FIG. 1 shows a conventional plasma reactor apparatus that includes a first matching network 23 designed for a first power source 21 generating a 13.56 MHz power signal, and a second matching

network 26 designed for a second power source 24 generating a 100 MHz power signal. Thus, a separate matching network is provided for each power signal generated from each power source.

Contrary to the Examiner's allegation, one would not have modified Ogino et al. to "implement ... the impedance matching network as taught by Yamagata et al in the apparatus of Ogino et al *in order .... to more efficiently apply [a] signal to the chamber*". (emphasis added.) Like most matching networks, the matching network 52 in Yamagata et al. is designed to allow a power signal of a single frequency (generated by power source 50) to pass to the processing chamber. The matching network 52 is not designed to maximize the passage of different power signal components having substantially different frequencies. For example, referring to FIG. 2 of Ogino et al., the illustrated waveform has first subcycles 25 with a frequency about double the frequency of the second subcycles 26. If one were to modify Ogino et al. with Yamagata et al.'s impedance matching network, the impedance matching network would, at best, only be suitable for maximizing the passage of the first subcycle 25 or second subcycle 26 of the power signal. The impedance matching network would not be suitable for both of the subcycles 25, 26, since they are at substantially different frequencies. Contrary to the Office Action, providing an impedance matching network in Ogino et al. would not allow one to "more efficiently apply" a signal to a chamber as alleged by the Examiner, but would make power delivery to the chamber "less" efficient, since all signal components of a power signal would not be efficiently transmitted to the processing chamber. In this regard, Ogino et al. actually teaches away from the modification proposed by the Examiner. As explained at MPEP § 2145, "[I]t is improper to combine references where the references teach away from their combination. *In re Grasselli*, 713 F.2d 731, 743, 218 USPQ 769, 779 (Fed. Cir. 1983)."

Only Applicants have explained how a single matching network and a frequency modulated power signal can be used together in a plasma processing apparatus. As explained at page 10, lines 1-16 of the specification:

> For the frequency modulated embodiments, the modulating signal may be at a lower frequency than the carrier signal. For example, in preferred embodiments, the modulation frequency, $\omega_m$, may be about one or two orders of magnitude lower than the carrier frequency, $\omega_c$. For example, the modulation frequency may be about 0.1 times or less, or about 0.1 to about 0.01 times the carrier frequency when the carrier signal is frequency modulated.
>
> When the modulation frequency is small compared to the carrier frequency, substantially all of the modulated carrier signal can still pass through the matching network adapted for the carrier frequency. This is true even if the modulated carrier signal includes frequency components which are higher and lower than the carrier frequency. For example, a typical matching network adapted to permit power at 100 MHz to pass to the chamber can also permit a substantial amount of power at frequencies between 98 MHz to 102 MHz to pass to the chamber without being reflected back to the power source. When a modulating signal less than about 1 MHz modulates a carrier frequency of 100 MHz, the frequency of the modulated carrier signal fluctuates within the range of 98 MHz to 102 MHz.

Unlike the present application, the cited prior art fails to explain how and why one skilled in the art would have used a single matching network and a frequency modulated power signal together in a plasma processing apparatus. Clearly, there is no motivation or teaching to modify the plasma reactor in Ogino et al. to arrive at the invention of claim 7.

2. *Obviousness has not been established, because there is no motivation to amplify the power signal in Ogino et al., since the power signal described therein is already at a suitable amplitude for etching.*

The Examiner also alleges that "it would have been obvious to one of ordinary skill in the art at the time of the invention to implement the amplifier ... as taught by Yamagata et al in the apparatus of Ogino et al *in order to amplify the modulated signal* and to more efficiently apply [the] signal to the chamber." (emphasis added.) Ogino et al. mentions the use of frequency modulated RF power for etching (abstract). Ogino et al.'s RF power signal is presumably already of sufficient amplitude to perform an etching process. If one were to "amplify" the power signal in Ogino et al. with an amplifier as alleged in the obviousness rejection, one would probably be sending too much power to

any wafers in Ogino et al.'s plasma reactor, thus making the etching process worse, not better. Accordingly, contrary to the Examiner's allegation, there is no motivation to modify the plasma reactor in Ogino et al. to "amplify the modulated signal" in Ogino et al.

*3. Embodiments of the invention provide advantages unrecognized by the cited art*

Embodiments of the invention provide for a number of advantages not disclosed in the cited references. First, by using only one matching network and a high power source, the resulting apparatus is less complex than a plasma processing apparatus using two matching networks and two high power sources. Eliminating a matching network and a power source also reduces the cost of the manufacturing the apparatus, since fewer components are needed to make the apparatus. Furthermore, because fewer components are present in the apparatus, the likelihood that the apparatus will become inoperative because of component failure is reduced. Second, by using a single matching network and a power source, the problems associated with interfering signals can be reduced. Two power signals can interfere with each other in a processing chamber and can cause arcing. Because different waveforms are not being applied to the chamber at the same time when a single power source and a single matching network are used, the likelihood of arcing is reduced in embodiments of the invention. Process parameters such as the RF power and the gas pressure need not be limited to reduce the likelihood of potential arcing. Consequently, in embodiments of the invention, processes with even wider gas pressure ranges and power variability can be practiced. Third, by using a single matching network and a single power source, additional matching networks and power sources are not present and will not divert power away from the reactant gas. Substantially all of the power from the power source can be delivered to the reactant gas in the chamber. Power is thus delivered efficiently to the chamber in embodiments of the invention. Fourth, since an additional matching network and power source are not present in embodiments of the invention, decoupling electronics are not needed to decouple the different power

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sources and matching networks. The presence of decoupling electronics in a plasma processing apparatus further increases its cost and complexity.

Also, in embodiments of the invention, high and low frequency signals are combined outside of the processing chamber under controlled conditions. Unlike conventional apparatuses, the interference between the carrier and modulating signals can be controlled by a process engineer before delivering the power signal to the chamber. The unintended interference of power signals within the plasma processing chamber can be avoided. Any unintended problems associated with the unintended interference of power signals are also avoided. Further descriptions of these and other advantages of embodiments of the invention are described at pages 13 and 14 of the specification.

## CONCLUSION

None of the prior art references cited by the Examiner discuss the specific combination of elements being claimed, and none of the cited references discuss the particular combination of advantages achieved by embodiments of the invention. Accordingly, it is respectfully submitted that the claims are patentable over the cited art.

In view of the foregoing, Applicants believe that there are many more reasons why the claims are allowable over the cited art, than not allowable. If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 415-576-0200.

Respectfully submitted,

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**VERSION WITH MARKINGS TO SHOW CHANGES MADE**

IN THE SPECIFICATION:

The paragraph beginning at page 1, line 13 of the specification has been amended as follows.

It is desirable to increase the number of controllable processing parameters in a plasma processing apparatus. More controllable process parameters provide process engineers with more ways to control the operation of the apparatus to optimize a given process. One way to increase the number of parameters is to use two separate, fixed frequency power sources instead of one fixed frequency power source in the plasma processing apparatus. Power signals at two different fixed frequencies can be applied to a reactant gas in the [apparatus'] processing chamber to form a plasma instead of power at one frequency. To further increase the number of process parameters, the duty cycles of the power signals can be modulated. Duty cycle modulation is described in detail below.

The paragraph beginning at page 12, line 22 is amended as follows.

The magnitude of the average power applied to the chamber may vary according to the particular process run on the plasma processing apparatus. The amplified high power modulated power signal may, for example, provide power in excess of 100 Watts to the chamber. For instance, in a typical [a] CVD process, the power may be greater than about 1200 Watts. In a typical etch process, the power may be greater than about 2000 Watts.

IN THE CLAIMS:

Claims 1-6, 9, and 14-32 are canceled.

The following claims are amended.

7. (Amended) A plasma processing apparatus comprising:

a carrier source adapted to generate a first RF signal at a carrier frequency;

a modulation source adapted to generate a second RF signal at a modulation frequency;

a modulator adapted to modulate the first RF signal with the second RF signal to form a frequency modulated signal; [and]

a plasma processing chamber coupled to the modulator;

a transmission line for transmitting the frequency modulated signal; and

a single matching network adapted to receive the frequency modulated signal to provide impedance matching from the transmission line to a plasma.

8. (Unamended) The apparatus of claim 7 further comprising:

an amplifier adapted to amplify the frequency modulated signal to generate a high power frequency modulated signal.

10. (Unamended) The apparatus of claim 7 wherein the modulation source is further adapted to generate a third RF signal at an amplitude modulation frequency, and wherein the modulator is further adapted to modulate the first RF signal with the second RF signal and the third RF signal to form an frequency and amplitude modulated signal.

11. (Unamended) The apparatus of claim 7 wherein the second RF signal is in the form of a sine wave.

12. (Unamended) The apparatus of claim 7 wherein the apparatus is an etching apparatus.

13. (Unamended) The apparatus of claim 7 wherein the modulation frequency is less than about 0.1 times the carrier frequency.

The following claims have been added.

33. (New) The apparatus of claim 7 wherein the modulation frequency is from about 0.1 to about 0.01 times the carrier frequency.

34. (New) The apparatus of claim 7 wherein the carrier source is at a frequency of about 13.56 MHz and wherein the single matching network is adapted to transmit power at a frequency of about 13.56 MHz to the plasma processing chamber.

IN THE DRAWINGS:

A Request For Approval Of Drawing Amendment is attached hereto, with proposed changes to FIGS. 1 and 2 shown in red. Approval of the proposed changes is requested.